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THE LEVELS OF PROCESSING CONCEPTUALIZATION OF HUMAN MEMORY: SOME EMPIRICAL AND THEORETICAL ISSUES

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Abstract

The consideration of human memory phenomena is an important element in the formulation of any valid model of human performance where information storage and retrieval demands on the part of the operator are known to be substantial. Various conceptualizations of memory have enjoyed empirical success over the years. Perhaps the most popular class of such conceptualalizations is characterized as multi-store. The fundamental tenents of this approach are that (a) information is submitted to a short-term store where capacity is limited and forgetting is explained on the basis of spontaneous decay and (b) that information may be transfered to a nearly limitless, long-term store where "failure to remember" is posited as an interference effect. Models based on these principles have prevailed primarily because of the heuristic value of the computer analogies which serve as their iconic bases. There are significant logical and empirical problems associated with these paramorphic models, however. A relatively recent tack has provided an alternative approach towards embracing a wide range of memory findings. The levels-of-processing (LOP) framework was introduced by Craik and Lockhart in 1972, and it has attracted a growing audience of skeptics and adherents over the past decade. The fundamental assumption of LOP is that it is the level--depth, and spread--breadth, of information processing which determines retrieval strength. This monograph examines the strengths and weaknesses of this fresh approach to memory phenomena.

INTRODUCTION

Encoding has always been a primary issue for those who are concerned with memory research--literally thousands of papers have explored the area since Hermann Ebbinghaus. But even before the late 1800s, the understanding of coding processes concerned many "pre-psychologists," as well. Perhaps most notably, were the early dualists. As Adams (1) noted, Plato likened memory in general to a block of wax in man's `mind':

> . . . of different sizes in different men; harder, moister, and of intermediate quality. . . that when we wish to remember anything which we have seen, or heard or thought in our own minds, we hold the wax to the perceptions and thoughts, and in that material receive the impression of them as from the seal of a ring; and . . . we remember and know what is imprinted as long as the image lasts; but when the image is effaced, or cannot be taken, then we forget and do not know, (1, p. 224).

Obviously, Plato conceptualized memory as soft and malleable--it changes with experience. Moreover, he recognized the special nature of recorded events. Simply stated, Plato considered encoding to be a primary determinant of retention and thus of forgetting. Although Aristotle claimed memorial functioning was localized in the heart (e.g., from him we have the expression "learn by heart")--and though Erasistratus corrected Aristotle's error, little true theoretical progress was made for memory in general or for encoding in particular until Ebbinghaus.

Aristotle introduced the concept of <u>associationism</u> some two-thousand years before its heyday of the 17-19th century with the British Associationists. Aristotle's notion, that ideas or thoughts are connected to and lead to others, was the fostering theme for the more systematic and direct study of memory which Ebbinghaus began. Related here was Ebbinghaus' controlled demonstration that <u>repetition facilitates learning</u>. The principal, lingering, unanswered question before the turn of the century, though, concerned the discovery of a mechanism: <u>How</u> does repetition enhance recall? Indeed, Ebbinghaus recognized the potency of encoding effects as did his contemporary, Kirkpatrick (1894). An adequate explanation of how repetition affects retention was critical to early formulations and is still central to any theory of memory.

The <u>continuity</u> approach (e.g., 35) to learning and memory held that each repetition of any particular stimulus-response coordinate strengthens the S-R chain in an incremental fashion. This explanation of practice effects contrasted sharply with the <u>noncontinuity</u> notion (e.g., 33) which insisted that learning grows as a total acquisition of the memory trace, or it doesn't grow at all. According to Estes (32), repetition provides opportunities for the trace to gain full strength. From this all-or-none approach grew a number of multi-<u>state</u> models of

memory (e.g., 12) and from these came the more recent multi-store models (e.g., 4, 72) The assumption that repetition simply provides the opportunity for a trace to transit among stores, then, is central to these theories. All of the aforementioned models emphasize structure; in fact "boxes" are often used to diagram short-term store (STS), long-term store (LTS), and the other pertinent components. Table I, from Craik and Lockhart (24) illustrates some of the important characteristics of state models (e.g., the all-or-none, store-to-store framework, as well as the inherent structural emphasis).

Table I

Commonly Accepted Differences Between the Three Stages of Verbal Memory (24)

Feature	Sensory Registers	Short-term Store	Long-term Store
Entry of Information	Preattentive	Requires attention	Rehearsal
Maintenance of Information	Not possible	Continued attention Rehersal	Repetition Organization
Format of Information	Literal copy of input	Phonemic Probably visual Possibly semantic	Largely semantic Some auditory and visual
Capacity	Large	Small	No known limit
Information Loss	Decay	Displacement Possibly decay	Possibly no loss Loss of accessibility or discriminability by interference
Trace Duration	1-2 seconds	Up to 30 seconds	Minutes to years
Retrieval	Readout	Probably automatic Items in consciousness Temporal phonemic cues	Retrieval cues Possibly search process

The consideration of encoding processes is obviously rich in history and it enjoys the attention of a healthy share of memory research today. However, encoding research is not exclusive to the verbal learning/memory research communities. Indeed, coding is typically conceptualized as a perceptual process. Perceptual

processes are, in turn, integrally related to memory. A few words regarding coding effects from a sensory-perceptual vantage will begin to demonstrate the pervasive influence encoding research has had.

In one of a series of papers, Conrad (20) found a strong tendency for subjects to make auditory confusions in the recall of letters originally presented visually, one at a time, five per list. That is, the letter `p' was often recalled as `V', which sounds like `p' ("e" sound); but it was not usually confused as an `f', even though `f' looks much like `p'. This finding suggested that the visually presented items were being recoded and stored auditorily, and the implication was that coding is effected in such a way as to emphasize the abstract quality and to ignore the physical details of the items. Interestingly, deaf persons typically make confusions among letters whose respective sign language representations are similar (21). Information can apparently be recoded from modality to modality although the tendency is no doubt task-dependent. For example, when it is necessary to reconstruct a spatial configuration which was originally specified auditorily to the subject, the optimal strategy is probably a recoding of the information into a visual mode. Brooks (15) in fact verified this possibility.

Perhaps the most provocative conceptualization of encoding today is the levels-of-processing (LOP) approach, the theoretical foothold for which was a paper written by Craik and Lockhart (24). The LOP approach was an attempt to reemphasize the functional aspects of memory (e.g., encoding), and it was a distinct departure from the prevailing structural, "box diagram" theories of retention.

THE LEVELS OF PROCESSING CONCEPT

It is easy to argue that the various "box" models of memory have a rather firm footing. For one thing, they are couched in ever popular computer terminology, and they are models. Designed to explain existing phenomena and to predict new findings, they have generated copious research. The LOP approach was by implication, a recognition that such structural models of memory are incomplete--they tend to ignore the more important functional properties of memory. While multi-store models emphasize the boxes, perhaps LOP emphasizes the arrows which connect the boxes. The major distinction of Craik and Lockhart's system, however, is its proposition that memory is based on the level to which an input has been processed. This is, in a sense, a return to the continuity notion of learning and memory, and it is a departure from the STS/LTS dichotomy which characterizes the structural models. Following is an outline of Craik and Lockhart's rationale and three-stage development of the LOP approach.

The levels of processing concept originated with a 1972 paper by Craik and Lockhart (24). This first stage in LOP's development represented a direct challenge to the assumptions of state models such as the one put forth by Atkinson and Shiffrin

(4). These store models had not gone unchallenged prior to 1972, however. Two challenges as noted by Craik and Lockhart include: (a) Tulving and Patterson (69) argued in 1968 against the notion of store-to-store transfer, and (b) in 1970, Shallice and Warrington (63) questioned the idea that information must pass through STS to enter LTS. The general adequacy of the modal models was challenged on three primary dimensions. First, Craik and Lockhart noted that the "exact nature of the capacity limitation is somewhat obscure," (24; p. 673). That is, the limitations of capacity were not clearly delineated as related to processing or storage. Broadbent (14) suggested capacity is governed mainly by processing limitations, whereas Waugh and Norman (71) implicated storage as the primary limiting factor. Miller (47) proposed that both processing and storage impose limits on capacity.

The second argument against store models concerned the proposed allegiances of short-term store (STS) with acoustic coding, and long-term store (LTS) with semantic coding. Baddeley's (5) work provided support for these coding linkages in memory but subsequent studies failed to strengthen the notion. Most importantly STS coding can be acoustic, articulatory (54), or semantic (64), and furthermore, even with verbal material, STS coding can be visual (42). Thus, no type of encoding is exclusive to one type of store. A distinction among stores based on coding alone is more confusing than explanatory.

The third point of departure for Craik and Lockhart concerned the respective forgetting characteristics of STS and LTS. The authors highlighted several methodological (e.g., paired-associate vs free-recall) and input type (e.g., visual vs auditory) considerations to show that STS and LTS cannot be unequivocally distinguished on the basis of trace durabilities. An obvious alternative to the STS/LTS dichotomy was to postulate many more stores--enough so that the roles of attention, rehearsal, motivation, task demands, etc., could be handled in a single but complex model. However, a concentration on code functioning rather than memory stores obviated the necessity to build such a cumbersome, *post hoc* theory.

According to Craik and Lockhart (24), many theorists (e.g., 67) have maintained that perception involves the rapid analysis of input at a number of stages. It is quite possible that this process of analysis proceeds in an orderly fashion, perhaps from simple to complex (e.g., from pitch, brightness and loudness discrimination to pattern recognition, to the extraction of meaning). Their point, then, is this: Processing results in a memory trace, the durability and strength of which depends upon the level to which the information has been processed. Furthermore, level of processing depends upon the current importance (e.g., meaningfulness of the incoming information), and it is arguably advantageous for an organism to recall information which is in some way highly meaningful or important.

It is noteworthy at this point to relate two qualifiers which Craik and his colleagues emphasized repeatedly (24, 25, 43, 50). First, level was not intended to imply a hierarchy of perceptual processing. Though it was assumed that certain processes probably precede others in some systematic fashion, Craik and Lockhart recognized from the outset that the order of processing of events is probably task-bound. 'Level', then, is an arbitrary experimental notion and memory is best conceptualized as the by-product of a continuum of perceptual analysis. Further, since speed of processing does not necessarily indicate the level of processing, and, as mentioned, since the perceptual elaboration of information does not proceed hierarchically, spread of encoding was suggested as a better descriptor of the encoding process and thus as a better ultimate predictor of retention, as will be discussed later.

The second qualifier concerned the theoretical status of LOP. As the title of Craik and Lockhart's 1972 paper indicated, levels of processing was at that point scientifically immature--LOP was a framework, not a theory. As such, or so the authors insisted, the LOP approach was not yet amenable to critical testing, and any relevant research was necessarily exploratory. Nelson (53), among others (e.g., 6), subsequently assailed this claim, but it is nevertheless important to note that the "framework theme" permeated the early LOP writings.

The levels approach incorporated James' (38) concept of a primary memory (PM)--a notion similar to Moray's (49) notion of a limited-capacity, central processor. Primary or "working memory" is free-floating and can be diverted to any processing level so that, in effect, items in PM are "receiving attention." Forgetting does not occur so long as the information is being maintained in PM, but when attention is diverted, forgetting proceeds at a rate appropriate for the level to which the information was being processed. The deeper the processing, the slower the forgetting. Thus, two types of perceptual processing were suggested:

Type I, or maintenance processing. Here, trace durability is not affected, and the total time hypothesis is not in effect. Information is merely being rehearsed at one analytical level.

Type II, or elaborative processing. Here, trace durability is affected and the total time hypothesis is in effect. Information is undergoing deeper and deeper analysis.

Central to the evolution of LOP were a series of studies of incidental learning. The importance of the incidental learning task lies in an orienting task's inherent ability to control the type of rehearsal or processing that the learner engages. Specifically, the orienting task can prescribe whether or not the subject uses maintenance or elaborative processing. Thus,

greater control is afforded under incidental than under intentional learning instructions. Craik and Lockhart cited several studies which used an incidental paradigm. The results generally paralleled those of Trasselt and Mayzner (68). Free recall, when the orienting task requires a semantic analysis of the to-be-tested items, is superior to the recall of phonemically processed words, or of structurally processed words, in that order. For example, Tresselt and Mayzner (68) instructed their subjects either to (A) cross-out all the vowels in each of a list of items, (B) copy the items to another page, or (C) determine if each word were an instance of the concept "economic." A subsequent surprise test showed that subjects in condition (C) recalled twice the number of items as did those in condition (B), and four times as many items as those in condition (A). That semantic processing produced greater recall than non-semantic processing was corroborated in a number of studies. As examples, Bobrow and Bower (10) replicated the effects with prose recall, as did Schulman (60) with target recognition. Further, and a bit surprisingly, a number of studies have shown that recall is no better after intentional instructions than after incidental instructions when maintenance rehearsal is dictated for the former condition and elaborative rehearsal is induced in the latter condition (44, 36, 39, 60). The upshot of these findings merits repeating: <u>Memorability</u> (apparently for recall <u>and</u> recognition <u>is a function of the level to which the relevant information has been processed</u>. Even at this point, however, Craik and Lockhart (1972) recognized that there is an important interaction between the characteristics of encoding and those of the subsequent retrieval task--an interaction that provides considerable insight about memory. This notion surfaces repeatedly in much of the LOP research and it will be discussed later.

Some of the converging support for LOP comes from sensory investigations (e.g., 67, 62). For example, Treisman (67) found that when an observer shadows a message delivered to one ear, the ability to detect a duplicate message delivered to the other ear is relatively high if the shadowed input precedes the other (even by as much as 4.5 sec). However, if the nonattended message/ear leads, the observer can detect the duplicate <u>only</u> when the lag does not exceed 1.5 sec. Thus, shadowing--deeper processing--can treble the durability of this type of memory trace.

The LOP framework also handled some rather time-honored memory phenomena. In the LOP view, the serial position curve was interpreted as a simple demonstration of the effects of type I vs type II processing, where recency items were assumed to undergo the former operation and primacy items, the latter. This account supposes that PM is maintaining the recency items when the recall test begins. The LOP approach predicts that under <u>delayed</u> recall, since 1) the terminal items had not been provided ample time for deeper processing, and 2) PM was no longer holding these items, recall for primacy items should exceed recall for recency items. Craik's (23) report of a <u>negative recency effect</u> confirmed this "postdiction."

The second and third stages in the development of LOP were papers by Craik and Tulving (25) and Lockhart, Craik, and Jacoby, (43) respectively. Craik and Tulving (25) provided much of the crucial evidence to bolster the original framework.

The series of ten experiments briefly summarized here begins with a reported replication of the levels effect using some alternative response measures. Here, as expected, different encoding questions led to different recall probabilities and different response latencies. Specifically, shallow processing (e.g., rating the item's surface form) produced shorter recognition latencies and poorer overall retention than did semantic processing (e.g., concept rating). This finding (in particular, the latency data), while supporting an LOP approach, highlighted an obvious confound. It was entirely possible that the longer latencies associated with the semantic condition provided more study time for each item and thus a more adequate check of the episodic store. Craik and Lockhart (24) recognized this possible problem in their closing caveat three years earlier, but it was an alteration of the basic paradigm which provided a clarification in this regard. Craig and Tulving (25) found that by inducing subjects to engage in a shallow but relatively time-consuming analysis of verbal material, recognition did not improve relative to that for a group of subjects who were required to perform a simple (i.e., less time-consuming) but deeper analysis of the material. In other words, even though study time was greater for the shallow processors, recognition performance was higher for the deep processors.

Another important outcome of the Craik and Tulving series was the recurrent finding that when a `yes' response was given to an orienting question about a particular item, that item was more easily recalled than an item whose orienting answer was `no.' Schulman (61) also found this strong tendency. The not so obvious explanation, in terms of LOP, was that when the orienting question and its referent item are well integrated, as occurs when a `yes' answer is given to such questions as "Is <u>cat</u> a four-footed animal," the integrative processing of the item <u>within its orienting context</u> is simply more congruous (elaborate?), and thus its trace is more durable. On the other hand, when a `no' answer is given, for example, to the question "Is <u>vacation</u> a four-footed animal," the incongruity between context and item precludes a deep analysis and `vacation' is thus ill-remembered. It is noteworthy that the effects of positive and negative decisions in the initial task held for both recognition and recall, and under both incidental and intentional learning conditions. This important issue will be discussed later.

In a demonstration of the robustness of the LOP phenomenon, Craik and Tulving (25) provided recognition data 1) from a loosely controlled classroom situation, and 2) from a situation in which differential cash rewards were offered for remembering words associated with different orienting tasks. In the former case, the typical semantic vs. non-semantic processing effects were replicated, and in the latter case, motivation was found not

to affect the pattern of results. The most adequate summary of the LOP research up to 1975 was provided by Craik and Tulving (25) themselves:

> It is abundantly clear that what determines the level of recall or recognition of a word event is not intention to learn, the amount of effort involved, the difficulty of the orienting task, the amount of time making judgments about the items, or even the amount of rehearsal the items receive; rather it is the qualitative nature of the task, the kind of operations carried out on the items, that determines retention, (p. 290).

The framework was rather clearly laid out at this point, but there were already some serious obstacles. These problems were considered both in the Craik and Tulving (25) article and the Lockhart, Craik, and Jacoby (43) chapter; the latter was the third primary stage of the LOP development, and following is a synopsis of the main problems and the attempts to resolve them.

From a logical standpoint, since structural analyses do not 'shade' into semantic analyses, the postulated set of analyzers simply cannot lie on a continuum. Thus, "domains of encoding" was substituted for "levels of encoding" and the explanation was as follows: While it is true that some analyses precede others, a full structural analysis is not usually carried out unless such is necessary to provide evidence for subsequent domains. In other words, _spread_, _elaborateness_, or _breadth_ (7) _of encoding_ are probably better descriptors of the memory function than is _depth of encoding_. At any rate, Craik and his colleagues retained "depth" for simplicity. The broad theme for LOP, then, was that 'subjects remember not what was 'out there' but what they _did_ during encoding," (25; p. 292). However, the most serious problem with LOP was an issue which Craik never belabored. Specifically, the problem was the lack of an independent specification of depth, breadth, spread, or elaborateness of encoding. This point has been stressed a number of times by LOP critics (e.g., 5, 6, 53) and it is still a problem. Nevertheless, LOP stimulated a great deal of research in a number of areas. Following is a review of some of that research.

RECENT APPLICATIONS OF THE LOP APPROACH

The undisputed findings in LOP research can be summarized in a few words: Semantic processing leads to better retention than does nonsemantic processing of the same material. This effect has been replicated many times as the Craik series of studies clearly showed. But there have been several independent and interesting investigations which have produced parallel findings. Most notably, Jenkins and his associates (36, 37, 70, 66) conducted a series of studies designed to investigate the effects of various orienting tasks on subsequent recall. The tasks varied from structural analysis, to syntactic analysis, to

semantic analysis, and each was performed under conditions of incidental and intentional learning. Generally, recall improved as encoding progressed from structural to semantic, and intentional learning was found to be no better than incidental learning when semantic processing was required in the latter. Similarly, Epstein and Phillips (31) found a facilitated recall of paired-associate words when the orienting task required subjects to find differences or similarities (semantic processing) between the items of the associated pair. Arbuckle and Katz (2) expanded this design, requiring subjects either to look for meaningful associations between paired items, or to rate the pair for rhyme. The "meaningful association group" showed consistently superior recall and recognition.

In another line, Postman and Kreusi (55) replicated the semantic-nonsemantic effect, but they also found that subjective ratings of list items (e.g., pleasantness) produced better recall than did objective ratings (e.g., frequency) of the same items. This, Postman and Kreusi interpret as an effect of rehearsal displacement. The notion here is that when an item is processed via its comparison with other intra-list items, and in a relatively subjective way, the rehearsal is said to be displaced. In other words, the comparison anchors derive from within the list; displaced processing, in this case, leads to improved recall. On the other hand, when the analysis for each item is independent of the other list items--i.e., when the rating is more objective, as in frequency assessment--rehearsal is rather diffuse and recall suffers. Although Postman and Kreusi (55) were attempting to redefine the levels phenomenon, their results fit nicely with Craik and Tulving's (25) address of Schulman's (61) congruity principle, mentioned earlier.

Another attempt to redefine the levels effect focused on the mechanisms which serve to mediate the effects of the orienting tasks. The redefinition was actually an effort to establish an independent description of levels or depth of processing. Accordingly, Hunt and Mitchell (35) instructed their subjects to produce one rhyme, or as many rhymes as possible for each of a list of words which were independently rated as either high (e.g., pride) or low (e.g., city) in rhymability. Similarly, other groups were instructed to produce one or as many <u>associations</u> as possible to lists of highly or lowly associable items. The interesting result (aside from the predicted semantic recall > phonemic recall) was that items which were paired with only one rhyme or association were better recalled than were the items which were paired with multiple rhymes or associations. Hunt and Mitchell (1978) referred to the one-pair condition as one which induces a specific-processing of the to-be-recalled items. In other words, some particular singular phonemic or semantic attribute of the word is being encoded, and this process enhances recall beyond that provided by a general (diffuse) encoding of the target item, with its many associations or rhymes. Thus, Hunt and Mitchell supported a distinctiveness hypothesis of orienting effects, and the implications for LOP are important. Since distinctiveness is an independently measurable

attribute, as the Hunt and Mitchell study indicated, and since specificity can predict retention in a number of situations, as the study also showed, the distinctiveness concept could provide much needed clarity for a levels of analysis approach by independently anchoring the measure of `processing level' and thereby obviating the circularity problem.

Earlier, Klein and Saltz (41) contributed in this vein as well in an effort to test and elaborate upon Saltz' (58) cognitive space model. Briefly, the model specifies that existing cognitive structures are composed of an infinite array of dimensions which are adjectival in nature (e.g., size, shape, movement). Many of the dimensions are associated with perceptual aspects of concepts while others are evaluative (e.g., pleasant vs. unpleasant). So, "a concept is defined as that region in cognitive space which is determined by the intersection of the attributed dimensions relevant to the concept," (58 p. 672). The model predicts that semantic processing should exceed orthographic processing in terms of recall since the nonsemantic processing does not specify the word's location on any of the attribute dimensions. More interestingly, however, the cognitive space model predicts that a specification of the region occupied by a concept on two intersecting dimensions will lead to greater definition, and thus to enhanced recall. Klein and Saltz found precisely that. When words were rated on each of two uncorrelated dimensions (e.g., big-little and happy-sad), incidental recall was substantially facilitated. Ratings of the same words on each of two correlated dimensions (e.g., pleasant-unpleasant and happy-sad), on the other hand, produced relatively little improvement in recall. Like the specificity notion of Hunt and Mitchell (35), this dimensions model provided another possible solution for the problem encountered with independent specification of depth.

One other effort was Battig and Einstein's (7) investigation of the effects of breadth of encoding--the terminology suggested by the previous works of Craik and Tulving (25) and earlier, by Craik and Lockhart (1972). Battig and Einstein (7) extended the paradigm of Klein and Saltz (41) by presenting the same to-be-remembered words a number of times and by increasing the retention interval to 48 hours. Interestingly, although broad processing in the form of multiple ratings of the items on relatively uncorrelated dimensions clearly improved delayed recognition, delayed recall was only slightly facilitated. Total processing was equivalent for the broad and narrow processing groups; the narrow group performed the same number of semantic operations, but on relatively correlated dimensions. Breadth or elaborateness of encoding within the semantic domain, then, seems to be more important than depth of processing--at least for recognition. The marginal improvement for recall may have been due to a floor effect (total recall was quite low: 15.4 percent), but it is also possible that recognition is more strongly affected by breadth of encoding than is recall (71). As Battig and Einstein (7) warn, while it is tempting at this point to peremptorily conclude that breadth of processing--determined

independently in terms of dimensional correlation--is the key to the levels approach, it is also possible that extremely broad or divergent multiple processing results in conflicts in coding (i.e., interference) and a reduced ability to remember. Indeed, Battig and Einstein found that three ratings did not significantly improve retention beyond that produced by two ratings. This is exactly what Hunt and Mitchell's (35) notion of encoding specificity would later suggest.

All of the above efforts required subjects to recognize or recall paired-associates or individual items presented in a list of such items. And in all of these studies, there was an effect of processing type on the ability to remember the episodic events. However, the LOP approach has emerged in less traditional verbal learning areas of memory research, as well. For example, Bobrow and Bower (10), and Schallert (59) found evidence for a levels effect in the recall of prose material. In the latter study, various titles were used to introduce otherwise ambiguous prose passages in order to induce subjects to interpret the passages in different ways. An independent assessment of each paragraph's strong and weak meaning was initially ascertained and the assumption was made that reading the material with a strong-meaning title would induce deeper semantic processing than would reading the material with a weak-meaning title. In other words, the relationship between the context (title) and the information in the passage should determine what and how much information was remembered. Schallert found that strong-meaning contexts did in fact produce superior retention, and passages without a title whatsoever produced better retention than did weak meaning contexts (i.e., subjects were apparently devising their own meaning). Furthermore, all of these semantic tasks led to higher memory scores than did counting the number of pronouns or four-letter words in the paragraphs. These results are in close accordance with LOP predictions.

Another interesting application of the LOP approach involved (episodic) memory for pictures. Nelson and Reed (52) in one study confirmed a levels explanation of recognition. On the other hand, D'Agostino, O'Neill and Paivio (26) favored a dual-coding hypothesis. The D'Agostino, et al. notion is that picture events are encoded visually, but they are also recoded verbally, and retention depends upon the processing of the dual code; structural, phonemic, and semantic processing--in that order--lead to better retention. Dhawan and Pellegrino (29) viewed "both theoretical positions (levels; dual-code) converging on an explanation of picture-word retention as a function of the relative capacity for semantic or associative processing," (p. 340, paraentheses added). As Conrad (20) also demonstrated with auditory confusions, the ability to recall episodic events is a function of the encoding-recoding-retrieval relationship. This is a particularly significant (though not exclusive) tenet of LOP research; it is an issue which will be discussed later.

Memory for faces has recently received the attention of LOP research, but the findings and interpretations are not altogether clear. Strand and Mueller (65), for example, reported a levels effect, where judgments of honesty (deep processing) led to better recognition than did gender identifications (shallow processing) of the facial images. In this case, deep processing produced better recognition in both expected and unexpected test situations. Winograd (73), however, explored the levels effect with an unusual arrangement of orienting tasks. Specifically, Winograd asked a group of observers to determine the most prominent feature (e.g., large nose) of faces as they were presented on a screen. He then ranked these features from the most frequently reported to least frequently reported and devised his orienting tasks so that an independent group of subjects were rating each face for the presence of a "high prominent" or "low prominent" feature. In this case, ratings for high prominent features led to better recognition. Winograd found a levels interpretation very awkward and instead described his results in terms of feature analysis (beyond the scope of this paper; see 51, 22). At any rate, facial recognition memory may not be affected by levels of processing. This negative report has been suggested by others (e.g., 7) and the discrepancies in picture and face memory might well hinge on this problem. Eye-scan recordings would provide some clues in terms of feature extraction. Another possibility might have artists reconstruct target pictures as a test of recall. This, rather than testing for recognition might be fruitful, although there would likely be problems in scoring the reconstructions as either "hit" or "miss."

SOME EMERGING ISSUES

As evidenced in the present review, and as Ebbinghouse anticipated almost a century ago, issues other than those concerned with the confirmation that semantic processing leads to superior retention heve arisen. For example, Craik and Tulving (25) reported that positive answers to orienting questions produce a more potent trace than do negative responses. This effect was subsequently reported by others (e.g., 18). The interpretation, as suggested by Craik and Tulving (25), Belleza, Richards, and Geiselman, (9), Belleza, Cheesman, and Reddy (8), and Bock (1977) among others, all using a variety of orienting procedures, is that the degree of organization between the item and its orienting context greatly affects the item's memorability. There is a hint, then, that any theory of retention must consider orienting task characteristics and test characteristics since retrieval is in some respects a reproduction of the original learning situation. In other words, memory is not just a function of input processing but also relies upon retrieval operations.

The relationship between input processing and retrieval operations was noted in a paper by Moscovitch and Craik (50). These investigators found that when the orienting questions were presented again as cues during the retention test, differences in

retention associated with different levels of processing were magnified rather than diminished. This means (a) that the differences in the accessibility of retrieval cues are not exclusively responsible for the effects of levels of processing , and (b) that retention is better described as an interaction of encoding and retrieval factors. As Moscovitch and Craik (50) pointed out,

> Recall performance depends (a) on the quality of the trace, (b) the presence of retrieval cues, and (c) on the degree of integration of the item with its encoding context. The quality of the trace, in turn, is a function of depth of processing; the compatibility of item and context will depend on their congruity from past experience, (60 p. 48).

Present assumptions about encoding-retrieval relationships suggest that recall is a joint function of the availability and accessibility of the items. But further, Moscovitch and Craik's (50) results suggested that an item's availability is determined by the level to which it has been processed, while its accessibility depends upon the efficacy of the retrieval environment. Ciccone and Brelsford (17), Fisher and Craik (33), Connor (19), and Hunt and Mitchell (35) seem to converge upon this argument. Memory depends upon how well-integrated a trace is within existing memory structures, and upon how discriminable that trace is within its organized store. It is interesting to note, and Moscovitch and Craik (1976) point this out, that words are structurally and phonemically more similar than they are similar semantically. That is, there is a more or less finite set of shapes and sounds which printed and spoken words can have, while the number of meanings they cumulatively hold is rather limitless. Thus, the levels effect might be reducible in part to a specificity concept wherein there is relatively little interference among responses within the semantic domain. Thus, there is greater retention for semantically encoded items. In their work, Hunt and Mitchell (35) and Klein and Saltz (41) pointed directly to this possibility.

PROBLEMS WITH LEVELS OF PROCESSING AND ITS PRESENT STATUS

Levels of processing has generated a wealth of research, and to its credit, it has raised as many questions as it has answered. But some of the questions that it raised concern its very own worth as a scientific model. These questions are empirical and theoretical, and they are beiefly examined next.

A basic tenet of the LOP framework is that repetition at a constant depth of processing does not enhance delayed recall. Several critics (e.g., 53, 6, 73) have shown that this is not necessarily so. For example, when the same rating question is used for each of the to-be-recalled items, multiple repetitions do facilitate recall (53). Similarly, Mechanic (46) found a repetition effect with nonsense syllables, and Dark and Loftus (27), using a Brown-Peterson design, reported a facilitation in

recall with simple repetitions of short sequences of words. Baddeley (6) cited other rehearsal effects (e.g., 289, 48). The LOP picture is somewhat blurred in light of these contradicting results, and it has proven difficult to explain these findings although papers by Rundus (57) and Winograd and Smith (72) may provide some clarity.

The Winograd and Smith (72) rationale, briefly, was that when subjects expect a test of retention, they organize the list items by associating or interrelating the items together, regardless of the orienting instructions. On the other hand, when no test is expected, and the orienting task demands semantic processing, the items are encoded individually. Winograd and Smith found a facilitation effect in that a <u>re</u>-test produced an improvement in recall beyond that for a single test, thus supporting the organization hypothesis. The interpretation was that the first recall test served to potentiate the organizational processing which in turn enhanced recall on the second recall test. McDaniel (45), moreover, found evidence for a 'clustering' effect with 24-h, delayed recall. In other words, a single test of recall may be insensitive to organizational encoding. The above findings do not deny a levels interpretation, as the mere report of a practice effect would superficially suggest. On the contrary, it seems that deeper processing, and not maintenance rehearsal, produced what in this case appeared to be a repetition effect. Furthermore, one must consider warm-up (56) and learning-to-learn (6) effects in any theory of episodic memory which is based on data collected in a laboratory. Ironically, all of the above experiments, while admirably attempting to exert precise control on the type of processing in which the subjects were engaging, found that the imposed control was simply inadequate. Given the opportunity, subjects may process items in more than one way (30). Indeed, that individuals may use elaborative encoding even under instructions simply to rehearse the items was a glaring outcome reported by Rundus (57).

There have been other empirical problems with levels of processing. As mentioned earlier, differences in recall and recognition performance have been cited in a number of reports (e.g., Arbuckle & Katz, 1976; Cermak & Reale, 1978) and the contrast is quite sharp. On the one hand, Battig and Einstein (1977) suggested that coding elaborateness may affect only <u>recognition</u>, while on the other, Baddeley (1978) suggested that coding elaborateness apparently affects only <u>recall</u> (if anything). Furthermore, Baddeley placed the onus squarely on the levels of processing proponents to explain the outcome inconsistencies produced by the two types of response measures. The recall-recognition issue is an old one and it seems that LOP has provided a new frame of reference for addressing the problem (e.g., 7); it has not clouded the issue, as Baddeley (6) indicated.

From a theoretical point of view, the most serious impediment for LOP has been the lack of an independent assessment of depth of processing. Although progress has been made (albeit ad hoc), as Hunt and Mitchell (35), with their "distinctiveness hypothesis," and Klein and Saltz (41), with their "dimensions model" have shown, the problem remains. Nelson (53) noted in what certainly appears to be a staggering challenge to LOP:

> "a claim comparing the number of same-depth repetitions (an independent variable) with depth of processing (another independent variable) is not tested during an empirical comparison of "over repetition" (one level of an independent variable that might be called the study-strategy variable) with either "silent rehearsal" (another level of the study-strategy independent variable) or "semantic rehearsal" (still another level of the study-strategy independent variable) . . . Although useful for providing answers to the question of how a learner should optimally use his time, this kind of empirical question cannot answer the question of whether the number-or-repetitions variable has a greater or lesser effect on memory than does the depth-of-processing variable," (p. 164).

Baddeley (6) also criticized LOP on other grounds of theoretical etiquette. According to Baddeley, the levels approach, with its constant modifications (e.g., the appeal to principles such as "compatibility" and "elaborateness"), and the recent incorporation of a retrieval concept (53), has grown repulsively awkward.

Craik and Lockhart (24) offered LOP as a mere framework or paradigm for conducting memory research. Nelson (53) asserted that although this appeal would seem to establish an immunity to attack and therefore a sense of security, the depth of processing view does not provide a totally valid description of the available data, and because valid description is a prerequisite for explanation and theory, the levels of processing framework is scientifically empty, (see 53; p. 168).

Despite Baddeley's (6) and Nelson's (53) compelling challenges to LOP, it is clear that the levels approach has made unique and valuable contributions. Arnoult (3) described good theory as that which is elegent (simple), powerful (accounts for a number of phenomena), fertile (predicts new phenomena), and testable (verifiable and falsifiable). While the levels system would not receive high ratings on these dimensions as it now exists, an independent and solid anchoring of the meaning of depth, breadth, or elaborateness of encoding would solidify the framework and firmly establish it as a viable theory. It appears that progress in this regard has been made.

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The consideration of human memory phenomena is an important element in the formulation of any valid model of human performance where information storage and retrieval demands on the part of the operator are known to be substantial. Various

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conceptualizations of memory have enjoyed empirical success over the years. Perhaps the most popular class of such conceptulalizations is characterized as multi-store. The fundamental tenents of this approach are that (a) information is submitted to a short-term store where capacity is limited and forgetting is explained on the basis of spontaneous decay and (b) that information may be transfered to a nearly limitless, long-term store where "failure to remember" is posited as an interference effect. Models based on these principles have prevailed primarily because of the heuristic value of the computer analogies which serve as their iconic bases. There are significant logical and empirical problems associated with these paramorphic models, however. A relatively recent tack has provided an alternative approach towards embracing a wide range of memory findings. The levels-of-processing (LOP) framework was introduced by Craik and Lockhart in 1972, and it has attracted a growing audience of skeptics and adherents over the past decade. The fundamental assumption of LOP is that it is the level--depth, and spread--breadth, of information processing which determines retrieval strength. This monograph examines the strengths and weaknesses of this fresh approach to memory phenomena. Keywords: